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PERFORMANCE AND DURABILITY OF AUTOCLAVABLE HIGH-SPEED DENTAL HANDPIECES

J. C. KUEHNE

M. E. COHEN

S. B. MONROE

Naval Medical Research and Development Command
Bethesda, Maryland

NAVAL DENTAL RESEARCH INSTITUTE
BUILDING 1-H
GREAT LAKES, ILLINOIS 60088-5259

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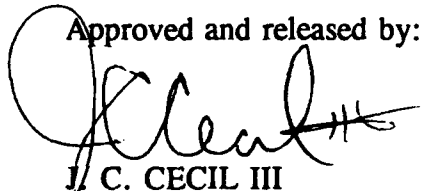


J. C. CECIL III
Captain, Dental Corps
United States Navy
Commanding Officer

SUMMARY

Ten handpiece models were evaluated and compared under clinical conditions at the Branch Dental Clinic, Recruit Training Command, Great Lakes, IL. Handpieces were assigned to dentists in a randomized sequence. Dentists used each model for one week and subjectively evaluated its performance by completing a questionnaire. The handpieces were cleaned and lubricated according to the manufacturer's instructions and sterilized by steam autoclave following each use. A detailed record was kept for each handpiece, documenting the number of sterilization cycles and specific problems noted. Data were analyzed to demonstrate the comparative durability and operating performance of each model. The rating of handpiece performance is a complex task, subject to many limitations and caveats as discussed in this report. It is not possible to reduce these variables to a simple yet accurate forecast of serviceable longevity. On the basis of our findings, however, we concluded that the following handpiece models are acceptable for Navy use: KaVo #632, Midwest Quiet-air, Midwest Tradition (or Tradition-L). We also concluded that, with current infection control practices, an average cost-life expectancy for dental handpieces in the Navy would be three years.

INTRODUCTION

Awareness and prevention of infectious disease transmission continues to be a major concern to the US Naval Dental Corps. In recent years, the increased threat of hepatitis B and HIV protection has mandated many changes in infection control procedures in the dental treatment room. However, sterilization of dental handpieces may have a potentially adverse effect on longevity and performance. Earlier handpiece sterilization studies have generally been confined to performance evaluations in a laboratory setting.[1,2,3] No study to date has adequately addressed handpiece longevity, durability, and performance under actual clinical conditions when sterilized following each patient treatment. This has important budgetary implications, given the increased number of handpieces required for effective infection control.

The Naval Dental Research Institute was tasked by the Chief, Navy Dental Corps (OP-093D)[4], to conduct a study to determine the longevity of autoclavable high-speed dental handpieces. The purpose of this investigation was to analyze and compare the durability and operating performance of different high speed dental handpieces under clinical conditions following repeated steam autoclave sterilization. It was designed to answer four basic questions: 1) How long will a handpiece last when sterilized following each use? 2) What are the major causes of failure? 3) What service is required? and 4) Which handpiece performs best in terms of durability and operator preference?

MATERIALS AND METHODS

The study was conducted at the Branch Dental Clinic, US Navy Recruit Training Command, Great Lakes, IL from May 1988 through January 1990. Thirty-nine dental officers from the departments of Operative Dentistry, Endodontics, and Prosthodontics participated in the study. The experience level of the dentists ranged from 0 to 29 years after dental school, with a mean of 3.1 years of clinical experience.

The study was divided into two phases. Seven handpiece models from five manufacturers (Table 1 and Figure 1) were originally evaluated. During the second phase of the study three other models (designated by an * in Table 1) were introduced. Ten handpieces of each model type were used in the study and were engraved with an identifying number. All handpieces were compatible with the Midwest In-Sight fiber optic system utilized in the clinic. With the exception of the KaVo models, handpieces were equipped with standard, four-hole couplers. Use of the KaVo handpiece required the separate installation of an adapter with its own fiber optic bundle. This additional interface resulted in some loss of light intensity which could easily be compensated for by increasing the dial setting.

Prior to utilization: 1) handpieces were weighed, 2) measurements were made of the head size (width and length) and angle of visibility, 3) each handpiece was photographed to document surface condition and quality of fiber optic light transmission, and 4) noise level and eccentricity were measured.

TABLE 1: List of High-Speed Dental Handpieces

1. KaVo 630 Multiflex Autochuck (K)
2. KaVo 632 Multiflex Autochuck (smaller head) (V)
3. Midwest Quiet-Air (Q)
4. Midwest Tradition (T)
5. Star 430 SL (S)
6. Lares 557 Turbo Plus (L)
7. Lares 757 (Larger head size) (W)
8. Adec (A) *
9. Midwest Tradition-L (Autochuck lever) (TL) *
10. Star 430SL Autochuck (SA) *

* Denotes models which became available, and were introduced, after the initial phase of the study had been completed.

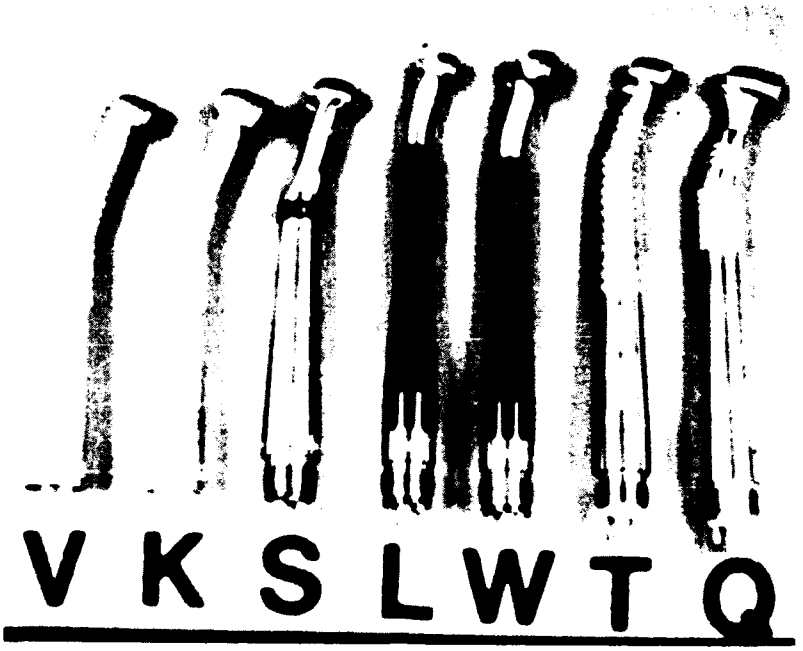


FIGURE 1: Seven handpieces initially included in the study. From left to right, KaVo 632, KaVo 630, Star 430 SL, Lares 557, Lares 757, Midwest Tradition, Midwest Quiet-Air.

A certified industrial hygienist from the Occupational Health and Preventive Medicine Department, US Naval Hospital, Great Lakes, measured the noise level for each handpiece on two decibel scales, dBA and dBC. The A scale measures higher pitched noise level while the C scale measures the lower pitched range. Instantaneous noise measurements were made 18 inches from the face of the handpiece using a sound level meter (a Type 2 GenRad, Model 1565B). The handpieces were tested as-received from the manufacturer after lubricating according to instructions and running for one minute with a new #330 bur, at the recommended air pressure.

Testing of eccentricity was performed at the American Dental Association Dental Materials Laboratory, Chicago, IL. Eccentricity is a measure of the wobble, or how "true" a bur turns when the handpiece is operating without load (maximum speed) at the recommended air pressure. It was measured by a non-contacting magnetic probe (KD-4111 SPL, Kaman Science, CO) tracing the three-dimensional movement of a cobalt-beryllium bur inserted into the chuck of the handpiece. Eccentricity of the bur at maximum speed was read (in 10^{-4} inches) directly from a digital display. Three measurements were recorded for each handpiece and the median value was used for computation of the mean values of eccentricity. The bur was removed from the handpiece, rotated, and replaced in the chuck between each measurement.

Phase I

The objectives of the first phase of the study were to 1) rate the handpieces subjectively from the clinicians' point of view, and 2) analyze handpiece performance under ideal maintenance conditions. Dental officers were assigned a different handpiece model to use each week, but might use any one of the ten handpieces of that model for each patient appointment. In order to achieve strict quality assurance for handpiece maintenance during the first phase, an NDRI dental technician was assigned to work full-time at the dental clinic. It was this technician's responsibility to clean, inspect, and lubricate each handpiece according to the manufacturer's exact instructions. He also collected and distributed handpieces and maintained a record for each handpiece, documenting the total number of sterilization cycles, the provider for each cycle, and any service performed other than routine maintenance. A separate room was designated for the exclusive purpose of handpiece maintenance. Following every treatment appointment, the used handpiece was cleaned, inspected, and lubricated by the technician according to the manufacturer's instructions prior to sterilization by steam autoclave. This procedure constituted one sterilization cycle.

Air pressure was checked and adjusted, if necessary, for each treatment room at the beginning of each week. At the end of each week, the dentist evaluated the handpiece by answering eight questions on a standard form (Figure 2). For each question, the dentist rated the handpiece by circling a number from 1 (Poor) to 7 (Good), with the number 4 identified as average. Additionally, the dentist was asked to select one handpiece which he or she preferred. The order of assigning handpieces to dentists for evaluation was randomized using a Latin Square.

Phase II

The objective of the second phase of the study was to gather information on handpiece durability and to analyze principal causes of failure under conditions typically experienced in Navy dental clinics. During this phase of the study, no modification was made to the standard clinical protocol for cleaning and autoclaving handpieces. Dental technicians assisting in each treatment room were instructed in the manufacturer's instructions for cleaning and lubrication appropriate for the handpiece model they were using. The importance of this maintenance was stressed during various training sessions, but the actual performance of it was the responsibility of the technicians. Personnel in the Central Sterilization Room (CSR) systematically steam autoclaved the handpieces and maintained records. The US Air Force Dental Investigation Service, Brooks AFB, San Antonio, Texas provided technical evaluation of the malfunctioning handpieces in order to help determine the cause of failure.

For each question, please circle one number between 1 and 7 to indicate your rating from Extremely Poor (1) to Extremely Good (7). The number 4 in each case should be considered as average.

NAME_____ DATE_____ DEPT._____

HANDPIECE (Circle One): (V)KaVo 632

(W)Lares 757 (Q)Midwest Quiet-Air (K)KaVo 630

(L)Lares 557 (small head) (S)Star 430SL (T)Midwest Tradition

	POOR			AVG			GOOD
I found visibility with this handpiece:	1	2	3	4	5	6	7
I found general feel (balance, length, weight) with this handpiece to be:	1	2	3	4	5	6	7
I found the cutting efficiency and power:	1	2	3	4	5	6	7
I found the vibration of this handpiece:	1	2	3	4	5	6	7
I found the water spray (aim and control):	1	2	3	4	5	6	7
I found the noise level with this handpiece:	1	2	3	4	5	6	7
I found the ease of changing burs with this handpiece to be:	1	2	3	4	5	6	7
I found the overall operation of this handpiece to be:	1	2	3	4	5	6	7

Of the handpieces you have used to date, circle the one you prefer:

No Difference (V)KaVo 632 (K)KaVo 630

(L)Lares 557 (small head) (Q)Midwest Quiet-Air

(W)Lares 757 (S)Star 430SL (T)Midwest Tradition

COMMENTS: (continue on reverse side)

FIGURE 2: HANDPIECE EVALUATION QUESTIONNAIRE

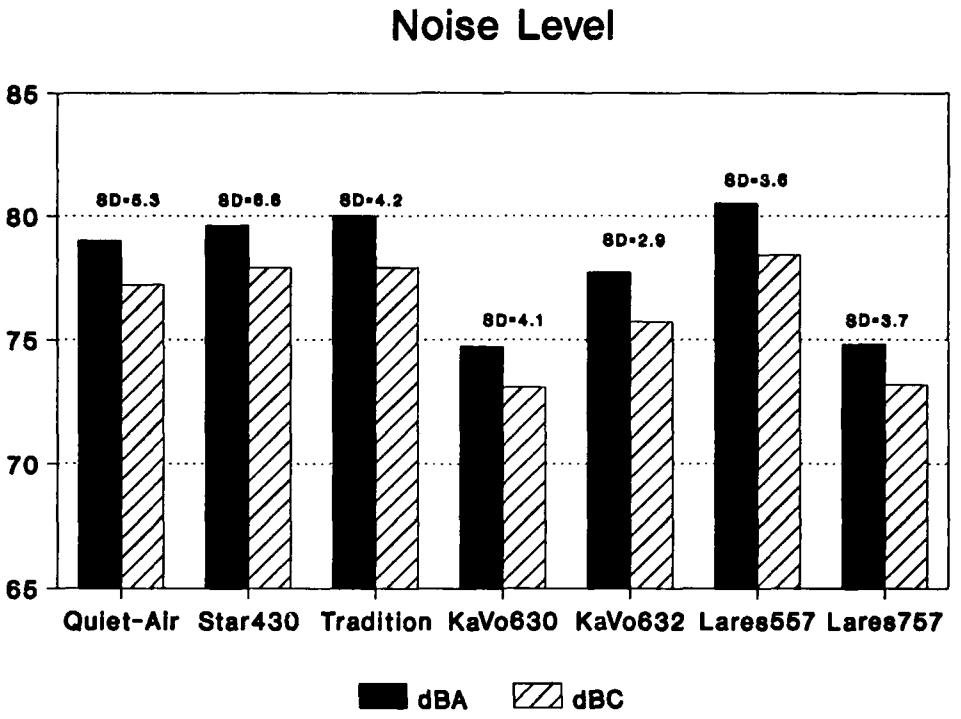


FIGURE 3: Graph of Mean Noise Level Measurements

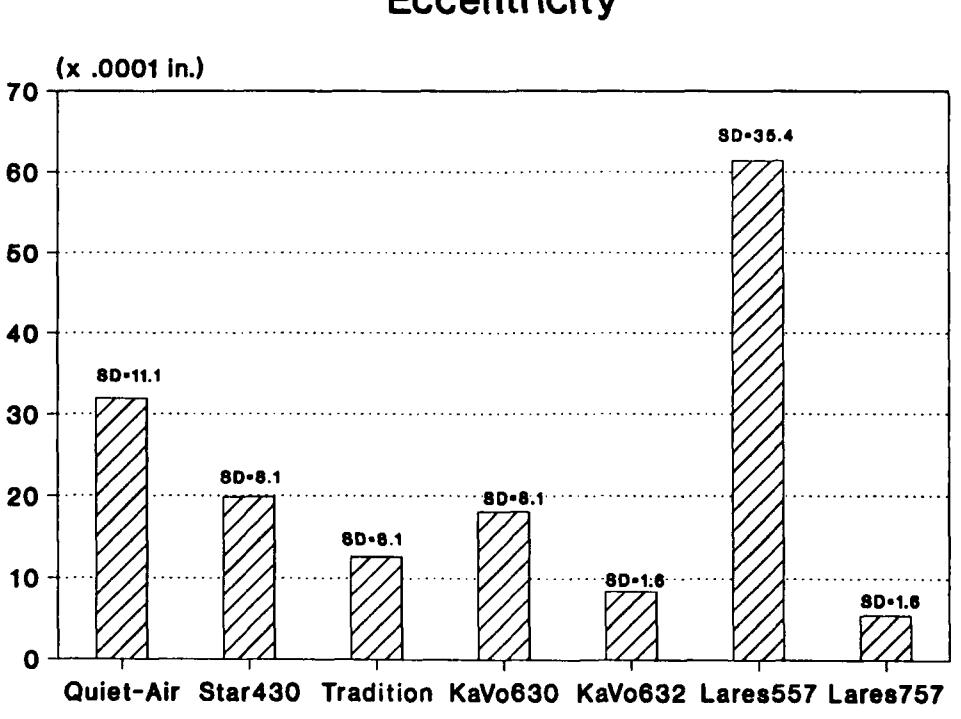


FIGURE 4: Graph of Mean Eccentricity Measurements

RESULTS

Mean scores for noise level and eccentricity for the new handpieces are presented graphically in Figures 3 and 4, respectively. There were statistically significant differences ($p < .0001$) among new handpieces for both variables. Periodic measurements of noise and eccentricity were made on handpieces throughout the course of the study. No significant correlation was found between either variable and overall performance or durability. On the basis of these findings, neither noise level nor eccentricity would appear to be useful for predicting handpiece performance or longevity.

Table 2 presents the mean scores from the dentists' evaluation of the handpieces from the questionnaires, while the mean scores for overall operation are presented graphically in Figure 5. It should be noted that none of the mean scores fell below 4.0, which was indicated as an "average" performance in the instructions. This suggests that the evaluators considered all of the handpieces in this study adequate during the evaluation period. This table also shows the percentage of dentists having a preference for each handpiece. Sixty-seven percent selected the KaVo 632 as their handpiece of choice. The Midwest Tradition was selected as the handpiece of choice by seventeen percent of the dentists in the study.

Table 3 shows these data analyzed by stepwise regression. This was done to determine which features of the handpiece were most influential in determining the clinician's overall evaluation. The dependent variable in this analysis was the response to question number 8 (Overall operation). The predictors were the responses to the other seven questions representing various features of the handpiece. The perception of cutting efficiency had the highest simple correlation (0.75) to the overall evaluation, and alone accounted for 56% of the variability in the rating. "General feel" of the handpiece also had a simple correlation of 0.75, and these two answers taken together accounted for about 74% of the variability in the subjective evaluation of overall operation. Although it was apparent that some features were clearly distinguishable when the evaluator had a definite opinion, a strong "halo effect" was observed in the answers; i.e., all the variables tended to be scored higher when the evaluator liked the handpiece, and all the variables tended to be scored lower when the evaluator disliked the handpiece.

Handpieces were ranked according to the measurements of head width, head length, cutting power, and noise level in order to determine which factors of handpiece design correlated best with the subjective evaluation of overall performance.[5] Head size, which influences both visibility and accessibility in the oral cavity, is a product of head width and length. Visibility, which can be measured directly as an angle, is determined by head width and taper. In the case of the handpieces used in this study, head width could be substituted for the angle of visibility without affecting the ranking. The score for overall operation was compared to the objective measurements of head size (width and length), cutting power, and noise level. The result of this analysis was that poor visibility (head width) and power, relative to other handpieces, have negative influences on the dentists' perception of overall handpiece perfo.. ance. Handpiece weight was not associated with any indicated preferences.

All of the fiber optic bundles in the handpieces which we evaluated degraded with continued autoclaving. Figure 6 demonstrates the degradation of light reflecting capacity which occurs over time in the fiber optic bundle when a handpiece is repeatedly autoclaved. This is a limitation of present technology in fiber optic construction and not peculiar to any one model of handpiece. Figure 6 (a) is a photograph of a new fiber optic bundle, (b) at 580 sterilization cycles, and (c) at over 2400 sterilization cycles. Light intensity is low to allow for contrast and visualization of light transmission along separate fibers, but there is a uniform pattern of transmission in the new bundle relative to the other two (i.e., light input had to be increased in the latter to obtain the same level of light intensity output by the new bundle). This is not necessarily a significant disadvantage if the fiber optic light is designed to initially deliver much more light than required for proper illumination. In that case, the degradation of fibers with time can be compensated for by increasing the intensity of the light source.[6] The Midwest, Kavo, and Star handpieces all supplied sufficient light throughout the study, as reported by the providers. Also evident in these photographs is the observation that the periphery of the bundle is very susceptible to breakage. Damage to the peripheral fibers is very common in new handpieces of certain manufacturers, and probably ocurs when inserting the bundle into the handpiece casing. Breakage of fibers on the periphery of the bundle continues in proportion to the amount of mishandling during the course of handpiece utilization.

Since a handpiece can fail to perform for any number of reasons, it is difficult to compare durability objectively using a simple statistical approach. Figure 7 is a graphical analysis of the relative durability of the handpieces during Phase I and Phase II of the study. At the top of each chart is the mean number of sterilization cycles and standard deviation for each handpiece group during that phase of the study (ideal maintenance represented by Phase I and normal clinical conditions represented by Phase II). Shaded bars represent the number of complaints of all types which caused a handpiece to be removed from service and examined. Table 4 is a listing of the most common complaints and the number of each received in parentheses. Many of these complaints were resolved by relatively simple maintenance and repair. Those that required the replacement of any handpiece part were categorized as a handpiece failure for the purposes of the study. The number of complaints which were determined to be failures are shown by the solid bars. The numbers in parentheses above the bars represent the mean sterilization cycle at which failure occurred.

TABLE 2: Mean Scores for Subjective Evaluation of Handpiece Performance.

	V	T	Q	L	K	S	W
Visibility	5.8	5.3	5.1	5.7	4.3	5.3	4.2
General Feel	5.8	5.3	5.2	5.3	4.9	4.9	4.5
Cutting Efficiency	5.7	5.5	5.2	4.4	5.1	4.5	3.6
Vibration	5.8	5.3	5.1	4.7	5.4	5.0	4.4
Water Spray	5.7	5.5	5.3	5.0	5.3	4.9	4.7
Noise Level	5.4	4.5	3.9	5.0	5.0	4.4	4.8
Ease of Changing Bur	5.7	4.4	4.1	4.9	6.0	3.8	4.8
Overall Operation	5.8	5.3	4.9	4.8	4.8	4.5	4.0
Preferred by (%)	67%	17%	2%	9%	0%	4%	0%

TABLE 3: Stepwise Regression of Handpiece Evaluation Data.

Step No.	Variable entered	r step 0	Mult. RSQ	F to enter	F model	df
1	Cutting effcy	0.746	0.557	217.33	217.33	1,173
2	Feel	0.745	0.741	122.75	246.52	2,172
3	Bur chng ease	0.454	0.768	19.19	188.12	3,171
4	Vision	0.550	0.786	14.94	156.33	4,170
5	Noise	0.464	0.798	9.64	133.35	5,169
6	Water spray	0.657	0.803	4.64	114.29	6,168
-	Vibration	0.695	-	0.74	-	-

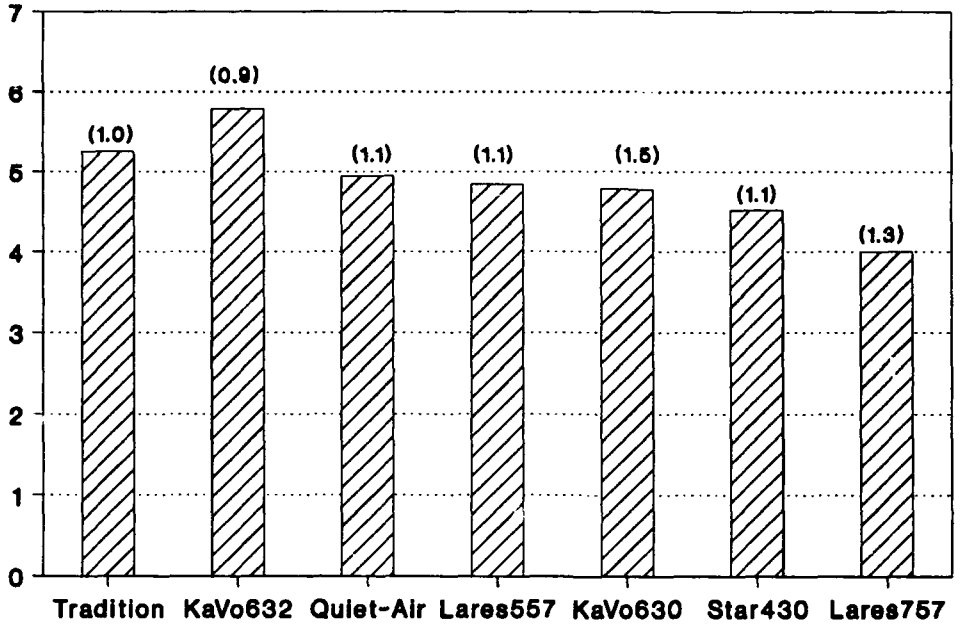


FIGURE 5: Overall Evaluation, Mean Scores ± (S.D.)

TABLE 4: List of complaints of handpiece performance.

Air/water port damaged (10)
Sounds bad/rough (9)
No water spray (13)
Chuck broken/doesn't function (11)
Bur won't turn / Low power (6)
Other (4)

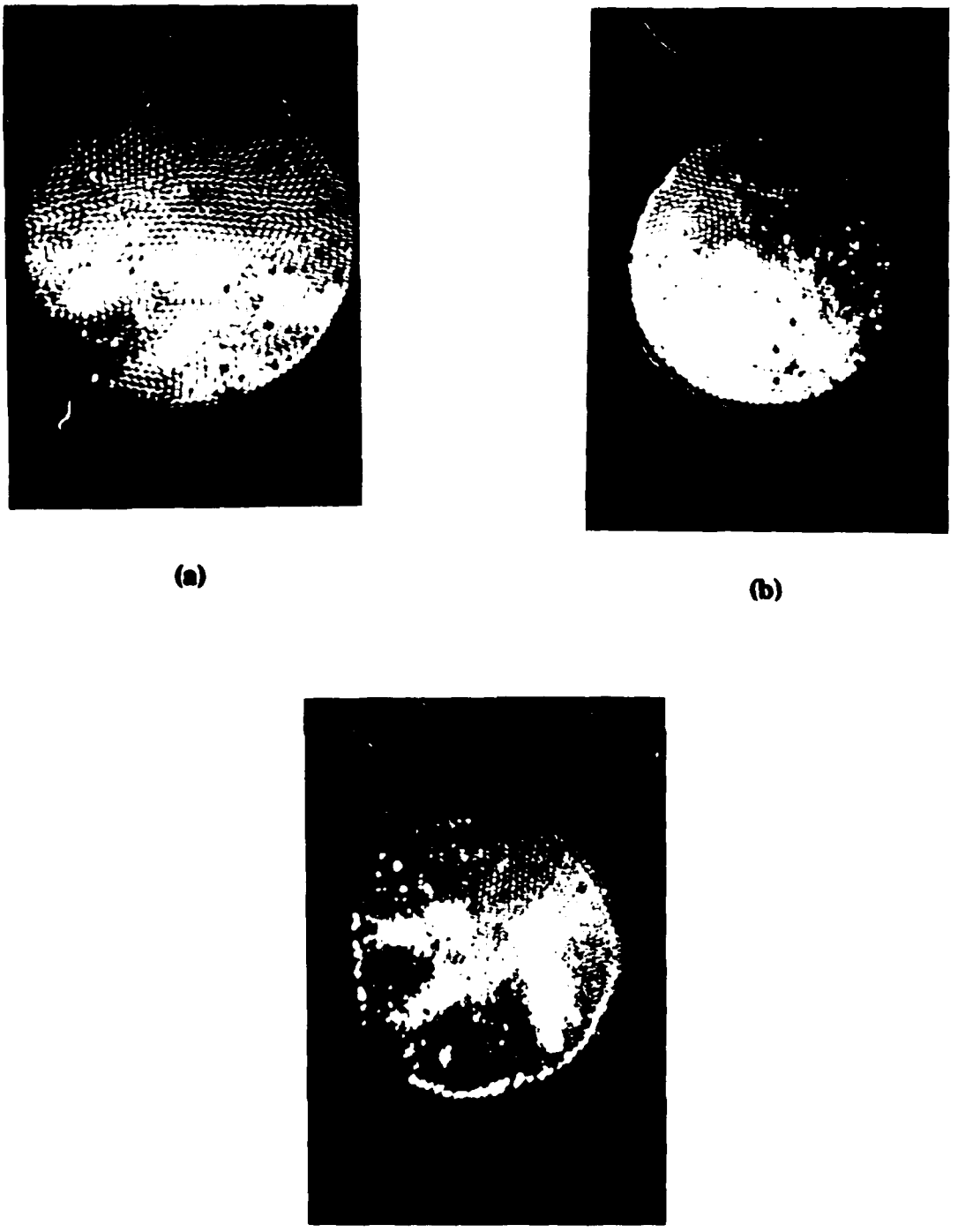
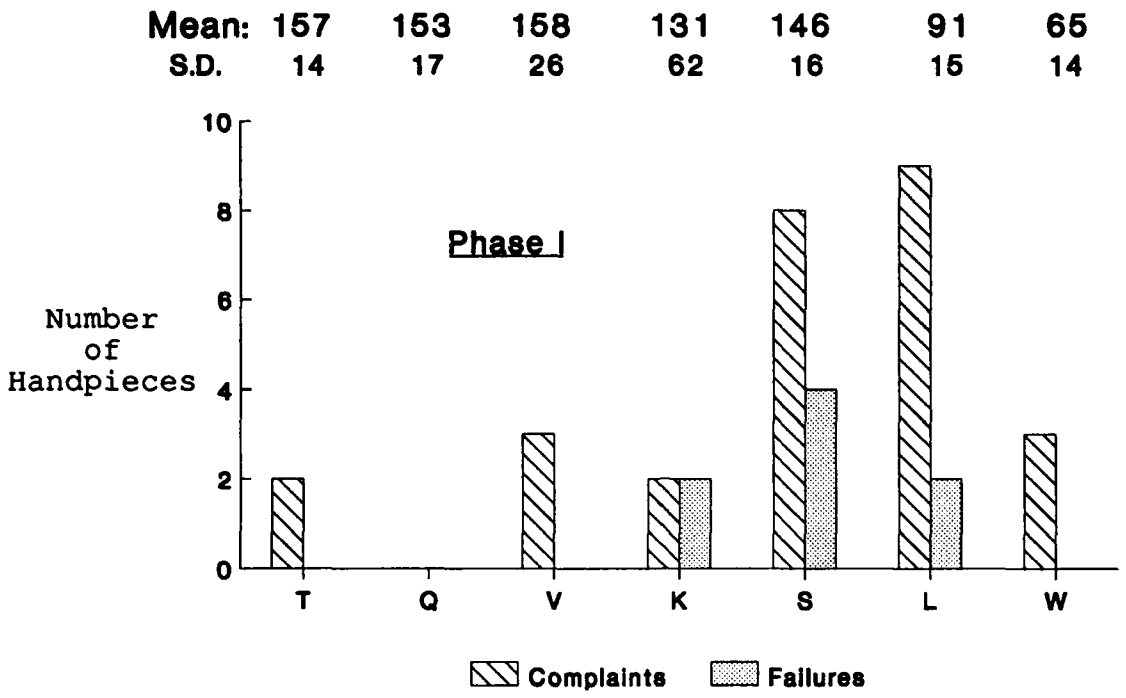


FIGURE 6: Photograph of magnified fiber optic bundles of handpieces after repeated sterilization cycles: (a) new; (b) after 580 sterilizatio: cycles; and (c) after 2400 sterilization cycles.



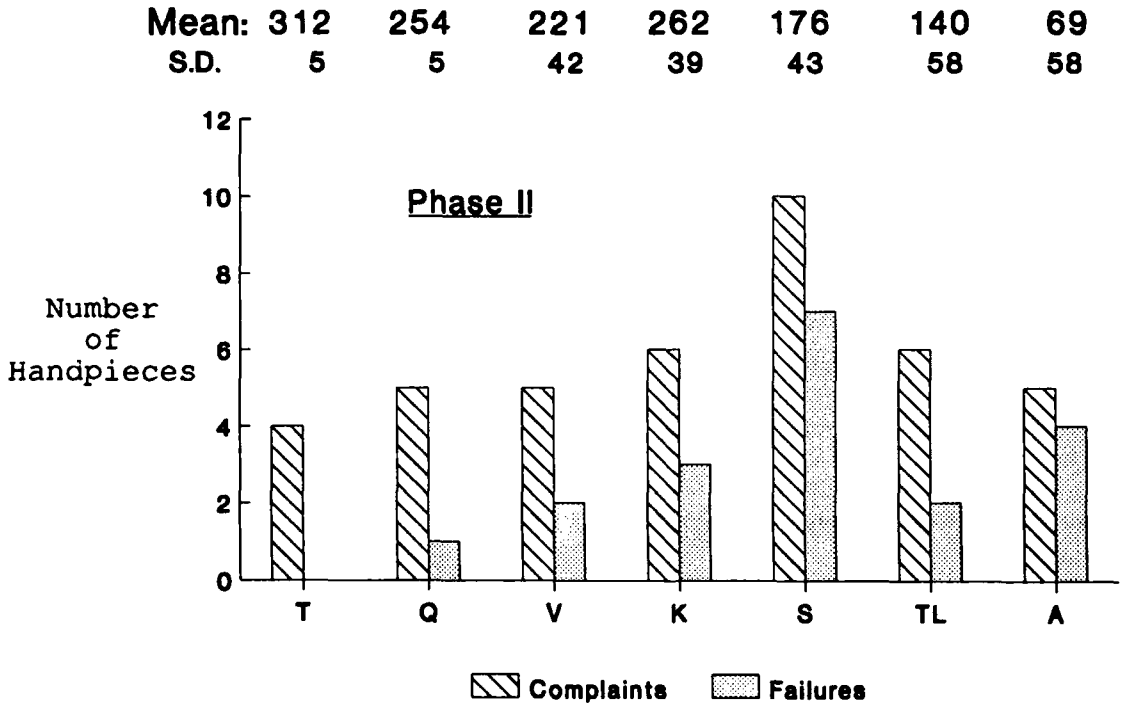


FIGURE 7: Handpiece Durability by Group, Phase I and Phase II. Mean number of sterilization cycles are at top of each column.

DISCUSSION

The final choice of a handpiece is dependent upon many factors including cost, performance, durability, ease of repair and maintenance, as well as special operating requirements, and the primary use for which the handpiece is intended. The results of our evaluations indicate that, regardless of the handpiece chosen for a particular need, the initial cost (especially considering government contract price differences) is probably not the most important consideration in choosing a handpiece. The most cost-effective handpiece is the most economical to maintain and repair over its entire useful life.

Some of the general features which are important in evaluating cost differences among handpieces are ease of cleaning and lubrication procedures; durability, including frequency and cost of repairs and maintenance; convenience and reliability of an autochuck mechanism; and heat-induced degradation of the fiber optic bundle which could lead to premature replacement of the handpiece.

Cleaning and lubrication of the handpiece is the single most critical factor for determining durability and operating performance. This represents a very important consideration, especially where a large number of handpieces must be handled daily. Increasing complexity of the cleaning procedure decreases the likelihood that it will be performed properly. The transfer of responsibility for handpiece maintenance from NDRI to the routine care performed by clinic personnel was accompanied by a dramatic increase in failures and complaints of all types. Although the rate of failures improved somewhat with increased training, it continued to highlight the need for effective daily preventive maintenance.

Because of the corrosive environment created by steam or chemical sterilization, lack of adequate lubrication will result in the single greatest reason for handpiece failures when all models are considered. Approximately 1.5 g of lubricant is required to adequately clean and lubricate a single handpiece.[7] Assuming two lubrications per sterilization cycle (as most handpieces require), 8 cycles (patients) per day, and 22 working days per month, each dental officer with a normal clinical workload will require approximately three 6 oz. cans of lubricant per month. This represents approximately $160 per dentist per year at current government cost. The actual amount of lubricant per dentist consumed by a clinic is probably the most reliable measurement by which to predict handpiece longevity. If handpieces are not adequately lubricated, the cost of repair and eventual replacement will be correspondingly high. This makes any prediction of the life expectancy of autoclavable handpieces very difficult since it can vary from months to years, depending upon use and the quality of maintenance provided. Anecdotal experience from various clinics over the past four years bears out this observation. The number and severity of problems a clinic reports with respect to high speed handpieces is almost invariably related to the awareness and attention paid to daily maintenance by clinic personnel. Thus, handpiece longevity should continue to improve as manufacturers make technological improvements in design, and as awareness of maintenance requirements increase among personnel.

Additionally, a few comments should be made regarding two important optional features on modern handpieces:

KaVo pioneered the autochuck mechanism (push-button chuck release) which allows the handpiece to be operated without a separate bur changing tool. This feature is becoming a standard feature on other handpieces. Midwest uses a lever operated chuck instead of a push-button available on the Tradition-L handpiece. In addition to the added convenience, the effect of this feature for the military is a huge savings by eliminating the cost of replacing bur changers which are lost or damaged.

Kavo has recently introduced a new technology in light transmission consisting of a single rod which conducts the light through the body of the handpiece. Although we have not yet tested these handpieces, it promises to totally eliminate the problem of light degradation with repeated autoclaving.

A final consideration is the health effects of the lubricant which is essentially an aerosol of synthetic oil, freon, and propane or butane. Even though testing by the Environmental Health and Industrial Hygiene Department, Great Lakes Naval Hospital demonstrated that published safe exposure levels were not exceeded under any clinical conditions, a number of technicians reported problems ranging from dizziness to headaches and slight nausea following periods when a large number of handpieces were lubricated in close quarters. While there is no documented cause for alarm, care and prudence would dictate that proper ventilation be used, and that the least amount of lubricant be used which is consistent with effective maintenance, especially where outside venting is not possible.

Following is a summary of the specific findings for each handpiece evaluated. Comparisons of different handpieces used in this study are valid insofar as they were randomly exposed to the same variables of use and maintenance. Caution should be exercised in extrapolating any results of this study to other situations since the performance of handpieces may vary when exposed to different conditions of handpiece use or maintenance.

Kavo #632 (small head version)

Kavo handpieces were reliable handpieces with very few operational failures. Overall performance was rated by our dentists as very satisfactory under all clinical conditions. KaVo handpieces offer some unique features which may prove desirable in certain situations. Chief among these are an excellent autochuck mechanism, and ease of repair and maintenance.

Kavo handpieces are designed to be cleaned and lubricated only once during the sterilization cycle, compared to other handpieces which must be lubricated before and after each sterilization. This effectively cuts the cost of lubrication, including the technician's time, in half. It also cuts in half the total amount of lubricant that is put into the air. The cleaning and lubrication procedure is the easiest and quickest to accomplish and is virtually foolproof. This, more than anything, probably accounts for their sustained clinical

performance. One disadvantage of using the Kavo handpieces with our present equipment is that a separate adapter must be used to connect the handpiece to the standard 4 hole tubing. This represents an additional cost of approximately $120 per unit. Some loss of light also occurs as a result of the additional interface but this is not a serious deficit. This is not necessary if the unit is originally equipped with Kavo tubing.

This handpiece was selected as the first choice of 67% of the dentists who participated in the evaluation. It was comparable to the Midwest Quiet-Air, and a close second to the Midwest Tradition, in terms of reliability, as measured by the number of failures over time. It had the most reliable, as well as the easiest operating, autochuck mechanism.

Kavo #630

The most common complaint of the Kavo #630 was related to its large head size which limited its usefulness for certain procedures, especially endodontic therapy. In addition, the metal end cap which surrounds the autochuck on the head was relatively soft and dented easily. This caused the push-button autochuck mechanism to malfunction, and burs could not be inserted or removed. KAVO has since replaced this metal with a harder alloy, so it should not be a problem on current handpieces. The larger head size would probably still exclude the KAVO #630 from major use in military clinics due to dentist preference. However, it should be considered for specialized situations where a heavier-duty handpiece is desired.

Midwest Tradition and Tradition-L

The Midwest Tradition is an excellent handpiece. It had the best durability record in our clinical trials. It received the second highest overall subjective rating by dentists for operating performance, a close second to the Kavo #632.

The new Tradition "L", which we also evaluated later in the study, has an autochuck mechanism composed of a lever arm. This mechanism is not quite as smooth, and may not be as durable, as the KaVo mechanism, but it nevertheless adds an important dimension to the handpiece and needs to continue to be evaluated for durability. The autochuck mechanism also adds an additional weekly maintenance step which must be performed. This is a significant disadvantage for military clinics, especially with a CSR, since it is often overlooked in their busy schedule.

Midwest Quiet-Air

The Midwest Quiet-Air is a standard to which many Navy dental officers were accustomed. It is a durable handpiece, although the Tradition fared better in our study. It is perhaps the easiest handpiece to repair in our present system because of familiarity with it by technicians. The size of the head is much larger than the Tradition or the Kavo #632, but is not as objectionable as the Kavo #630 due to its tapering design. Probably its most

objectionable feature is its noise level. This and the lack of an autochuck dropped its rating in the evaluation, but it nevertheless has a long history of solid and dependable performance which should be weighed when making major purchases.

Star 430 SL

The Star 430 handpieces were good performers and evaluated well when new, but demonstrated extremely poor durability with use. They are one of the handpieces which would not be recommended at the present time. Of twenty handpieces tested (ten standard handpieces and ten autochuck models added one year later): 4 failed as a result of loss of the retaining pin, 9 failed as a result of one of the metal ports breaking off or being damaged beyond usefulness, 2 required new chucks, and 1 autochuck mechanism failed. They are also the most difficult to effectively lubricate. Star has since made significant improvements in design, including the quick-connect, 360 degree swivel, eliminating the metal ports which were the greatest cause of failures in this study.

Lares 557 and 757

The Lares handpieces, 557 (small head) and 757, are also not recommended for use at this time. Although there are some positive features to these handpieces, and they were evaluated well when new, they deteriorated rapidly with repeated autoclaving and were discontinued after only a few months. We believe the principal reason for this is a lack of effective lubrication. Lares is the only handpiece which does not utilize an aerosol spray lubricant, but instead employs a very viscous mineral oil liquid. In every head assembly which was examined microscopically, the bearings were dry, as though they had not been lubricated effectively. This would explain the poor life expectancy which was demonstrated when autoclaved. From the results of our evaluation, they would have to be rated at present as a non-autoclavable handpiece.

Adec

Finally, Adec handpieces were evaluated. These had a very poor rating and were not well accepted by dentists in our clinic. There were numerous complaints and problems, primarily related to an irritating sound which increased after relatively few sterilization cycles. Also, power tended to vary more widely than other handpieces and was often reported as inadequate. A high failure rate was experienced for the short time they were used. They also are not recommended for use at this time.

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Ten handpiece models were evaluated and compared under clinical conditions at the Branch Dental Clinic, Recruit Training Command, Great Lakes, IL. Handpieces were assigned to dentists in a randomized sequence. Dentists used each model for one week and subjectively evaluated its performance by completing a questionnaire. The handpieces were cleaned and lubricated according to the manufacturer's instructions and sterilized by steam autoclave following each use. A detailed record was kept

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for each handpiece, documenting the number of sterilization cycles and specific problems noted. Data were analyzed to demonstrate the comparative durability and operating performance of each model. The rating of handpiece performance is a complex task, subject to many limitations and caveats as discussed in this report. It is not possible to reduce these variables to a simple yet accurate forecast of serviceable longevity. On the basis of our findings, however, we concluded that the following handpiece models are acceptable for Navy use: KaVo #632, Midwest Quiet-air, Midwest Tradition (or Tradition-L). We also concluded that, with current infection control practices, an average cost-life expectancy for dental handpieces in the Navy would be three years.